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To Innovate or to Transfer?

A Study on Spillovers and Foreign Firms in Turkey

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Abstract: FDI has been considered by many development economists as an important channel for transfer of technology to developing countries. It is suggested that modern, advanced technologies introduced by multinational firms can also diffuse to domestic firms through spillovers. In this paper, we study innovation and technology transfer activities of domestic and foreign firms in Turkish manufacturing industries, and the impact of horizontal, vertical and labor spillovers on these activities. Our analysis shows that foreign firms are more innovative in than their domestic counterparts, transfer technology from abroad (mostly from their parent companies), and are likely to establish more co-operative relations for their R&D activities. Horizontal spillovers from foreign firms seem to be insignificant. The effects of foreign firms on technological activities of other firms in vertically related industries are ambiguous. Foreign presence in user industries induces innovation, but foreign presence in supplier industries is detrimental for innovation in medium- and high-tech industries. Labor turnover is the main channel of spillovers. Our findings reiterate the importance of tacitness of knowledge, and confirm that technology cannot easily be transferred through passive mechanisms (demonstration effects, imitation, etc.).

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1. Introduction

There are two strands of the literature in development economics that have attracted substantial interest in the last couple of decades: the importance of technological change for long term economic growth and the role of foreign direct investment (FDI) in the process of economic development. Studies on technological change emphasize the fact that innovation (the development of new products, processes and organizations) is basically an interactive process. Recent advances in science and technology have led to, on the one hand, an increase in knowledge content of products and processes, and, on the other hand, the importance of generic technologies that can be used in various products and processes. These two processes, that form two sides of the same coin, have increased the need to extend the knowledge base of industrial firms. As Rosenberg already suggested 20 years ago, the process of innovation cannot fit into the boundaries of a single firm. Therefore, firms can now innovate only within an intensive web of interactions with other firms (suppliers, buyers, and, even, competitors), consumers, research institutions, etc, i.e., they can be innovative, and, thus, competitive, only if they can form and be part of *innovation networks* (for a small group of studies, see Lundvall, 1988; Nelson and Rosenberg, 1993; Smith, 1995; OECD, 1999 and 2000).

FDI has been considered by many development economists as an important channel for transfer of technology to developing countries. It is suggested that modern, advanced technologies introduced by multinational firms can also diffuse to domestic firms through spillovers (imitation, demonstration effects, training local labor, vertical technology transfers, etc.). However, empirical studies show that the net benefits the host country can enjoy from FDI depends on host country characteristics, like industry and policy environment (Blomström and Kokko, 1998), the level of human capital stock (Borensztein, Gregorio and Lee, 1998; Noorbaksh, Paloni and Youssef, 2001), and absorptive capacity of domestic firms (Kinoshita, 2001).

This paper contributes the existing literature by presenting new evidence on the interactions between domestic and foreign firms within innovation networks in Turkish manufacturing industries. The aim of this paper is three-fold: i) to analyze differences in innovative performance of domestic and foreign firms, ii) to investigate the types of interaction domestic and foreign firms are engaged in, and iii) to test if foreign firms play a role in

developing innovative capability of domestic firms by participating in innovation networks (see also, Reger, 1998; Smith, 1995). This is an important issue, because as shown in an earlier study (see Özçelik and Taymaz, 2004), innovativeness is an important determinant of international competitiveness in developing countries, too.

The paper is organized as follows: The second section provides the background information on FDI in Turkey. The innovative performance of foreign and domestic firms is compared in Section 3. The data sources, models for innovativeness and technology transfer and estimation results are discussed in Section 4. The last section summarizes basic findings.

2. Foreign direct investment in Turkey

The first legislation in Turkey governing foreign investments was introduced in the early 1950s. The Foreign Capital Law was enacted in 1954 and the related Decree of the Council of Ministers had remained in force until the late 1980s. This early legislation provided a liberal framework designed to create a favorable environment for FDI. However, the *cumulative* FDI authorized from 1950 to 1980 reached only 229 million USD (Öniş, 1994). Restrictive bureaucratic practices by government institutions, and most importantly by the State Planning Organization, who were suspicious of foreign capital, were blamed for the low level of FDI in Turkey in the pre-1980 period (see, for example, Erdilek, 1982).

Turkey had to abandon the import substitution industrialization strategy followed in the 1960s and 1970s after the severe balance of payments crisis in the late 1970s. On January 24, 1980, the Turkish government announced a stabilization program that was fully implemented under the military regime after September 1980. The new program was based on outward-oriented trade strategy and foreign trade, product, and, later, capital markets have been liberalized to a large extent (for a comprehensive overview of the Turkish economy, see Kepenek and Yentürk, 2000).

The administrative system regulating FDI was reorganized in the early 1980s to simplify investment procedures and to eliminate ambiguities arising from the fragmented bureaucratic structure. Moreover, all discriminatory treatment foreign investor were subject

to and conditions on local equity participation were gradually eliminated (Erdilek, 1986; Akpınar, 2001). The complete liberalization of capital accounts in 1989 provided an additional impetus for foreign investment. As a result, the number of firms with foreign participation increased from 78 in 1980 to 1,856 in 1990 and to 5,328 in 2000, whereas total value of inflow of FDI reached 2.6 billion USD in the 1980-89 period and 11.8 billion USD in the 1990-2000 period.[1] The manufacturing industry alone accounted for 55% of cumulative authorized FDI in the post-1980 period.[2]

The annual FDI has been about one billion USD in the 1990s. Many analysts claim that Turkey is under-performing relative to the Central and East European Countries and other countries at the same level of development in attracting FDI (see, for example, Loewendahl and Ertugal-Loewendahl, 2000). However, an analysis of foreign firms' share in Turkish manufacturing employment and value added suggests that FDI plays a substantial role in Turkish manufacturing industries.

The share of foreign firms[3] in total number of private firms in the manufacturing industry was about 1 % in 1983, but it increased continuously up to 2 % in 1999, and 3.5% in 2000 through acquisitions and entry.[4] The share of foreign firms in private manufacturing employment was about 6 % with 50 thousands people employed by foreign firms in 1983. Employment share of foreign firms increased gradually, especially after 1988, and reached 11 % in 2000.

Foreign firms prefer to invest in medium- and high-technology industries[5]: their share in value added increased continuously from about 25% in the mid-1990s to almost 50% in the late 1990s (see Figure 1). On the other hand, the share of foreign firms in low-tech industries increased gradually until the mid-1990s and stabilized around 13-15%

[1] For the data on inward FDI and the list of all firms with foreign equity participation, see the web site of the Undersecretariat of Treasury (http://www.hazine.gov.tr).
[2] The share of the manufacturing industry in total FDI was about 88% in 1977 (Öniş, 1994: 9).
[3] Following the usual convention, "foreign firms" are defined as those joint vetures where foreign ownership is 10 % or more. If the foreign share is less than 10 %, it is considered to be portfolio investment. Joint ventures with more than 50% foreign ownership are "majority-owned foreign firms".
[4] The data refers to all *private* establishments employing 10 or more people, and all public establishments. The statistical unit is the "establishment" which is the main decision-making unit.
[5] We use OECD's definition of low-, medium- and high-technology industries. Since the number of firms operating in high-technology industries is small, medium- and high-technology industries are grouped together, and defined as "high-tech".

afterwards. In other words, the increase in foreign investment in manufacturing since the mid-1980s is mainly due to the attractiveness of high-tech industries.

The value added share of majority-owned foreign firms follows a similar pattern. Majority-owned foreign firms did not increase significantly their share in value added until 1987. However, after the elimination of local equity participation and minimum export requirements in 1986 (Öniş, 1994: 96), majority-owned foreign firms realized a rapid growth in their valued added share throughout the period under consideration. In other words, all the expansion in value added share was achieved by majority-owned foreign firms, whereas minority-owned foreign firms (with equity participation within the 10-50 % range) kept their shares almost constant.[6]

Foreign firms are on average more productive than domestic firms, and the productivity[7] differential is much wider in low-tech industries: foreign firms in low-tech industries have been 2.5-3 times more productive than domestic counterparts (Figure 2). High-tech foreign firms in Turkey have been 2 times more productive, but the productivity differential has widened in recent years and reached 150% (2.5 times) in 2000.[8]

We use the US productivity data in order to compare the productivity of foreign firms with the "best practice" productivity. It is interesting to observe that low-tech foreign firms in Turkey are as productive as US firms, but high-tech foreign firms in Turkey lag behind their US counterparts.

Policy-makers in Turkey since the early 1980s have claimed that FDI is an important channel for transfer of technology from abroad, and introduced various measures to attract foreign capital. However, there is not any comprehensive study that analyzes the contribution of foreign firms in transferring technology from abroad, and its subsequent diffusion within the manufacturing industry through spillovers. In this paper, we test if

[6] Cieslik and Ryan (2002) also found a similar shift from minority-owned joint ventures in the Central and Eastern Europe in favor of wholly-owned foreign firms.
[7] Productivity is defined as "labor productivity", i.e., value added per employee. Current exchange rate is used to calculate USD denominated productivity of Turkish firms.
[8] One of the main reasons behind productivity differential between domestic and foreign firms is the size differential. Foreign firms are, on average, 2.5 larger than domestic ones. Note that the productivity differential between large (employing at least 150 people) and small (employing 10-149 people) firms in low-tech industries was about 60% in the late 1990s whereas the same rate was almost 150% in high-tech industries.

foreign firms are more likely to transfer technology from abroad, and if they have any impact on the choice of technology by domestic firms. Since earlier studies have shown that innovative activities by domestic firms are essential to build technological capabilities, we also look at the determinants of innovative activities. More specifically, we look at three types of spillovers from foreign to domestic firms:

- *Horizontal spillovers* (spillovers from foreign firms to domestic firms operating in the same industry or in the same region)
- *Vertical spillovers* (spillovers from foreign firms to domestic firms operating in vertically related industries, i.e., for suppliers and customers)
- *Labor spillovers* (spillovers through labor turnover, i.e., employment by domestic firms of workers who worked for foreign firms)

Following Pavitt's warning on the importance of inter-sectoral differences in technological activities (see Pavitt and Patel, 1999), we analyze the effects of spillovers from foreign firms for low-technology and medium- and high-technology industries separately.

3. Innovativeness of domestic and foreign firms

Turkey has followed quite closely the innovations in collecting the data on innovative activities. The State Institute of Statistics (SIS) conducted two innovation surveys following the methodology set by the *Oslo Manual (*OECD, 1997), and the *Community Innovation Survey* of the European Union. The first survey conducted in 1998 covering the period 1995-97, and the second one conducted in 2002 for the period 1998-2000. "Technological innovation" is defined in the questionnaire as "technologically new products and processes or significant technological improvements in products and processes". Innovation is explicitly defined at the firm level, i.e., "innovation occurs when a firm implements a new or improved product or process which is technologically novel for the firm, not for the market". The response rates were more than 50 percent in both surveys. The SIS performed a non-response analysis and estimated sample weights for each respondent.

Table 1 summarizes the data on the innovativeness of domestic and foreign firms in the periods 1995-1997 and 1998-2000 for low-tech and high-tech industries. It is interesting to observe that there is almost no difference in terms of product innovations between domestic and foreign firms in low-tech industries. For example, only 11.2% of domestic firms introduced any product innovation in the period 1995-1997, whereas the proportion of foreign firms who introduced product innovations in the same period is even slightly lower (9.1 %). The proportion of innovative firms has increased in the second time period (1998-2000), but the difference between domestic and foreign firms is not significant. Foreign firms in low-tech industries seem to become more successful in process innovations than their domestic counterparts in the second time period.

Firms operating in the high-tech industries are almost two times more innovative than firms operating in low-tech industries, and foreign firms in these industries are undoubtedly superior to domestic firms in innovativeness. The data provides strong evidence that support the argument that domestic firms are technologically weaker than foreign firms in high-tech industries.

The relative importance of product and process innovations differs in low-tech and high-tech industries, and the ownership of the firm matters for the type of innovation. Product/process innovators ratio is much lower in low-tech industries than in high-tech industries. In other words, process innovations are more common than product innovations in low-tech industries. Moreover, foreign firms put more emphasis on process innovations than domestic firms do. Since low-tech industries tend to have “mature” product technologies, process innovations are likely to play more important role for productivity and competitiveness, where foreign firms seem to have a competitive advantage over domestic ones. Product/process innovators ratio is much higher in high-tech industries than in low-tech industries, and foreign firms have even higher ratio of product-to-process innovators. This finding supports the perception that high-tech industries play a leading role in developing new products.

The distribution of innovation expenditures over various categories of activities provides additional evidence on the differences in technological activities between domestic and

foreign firms.[9] Domestic firms in low-tech industries spend relatively more on in-house R&D activities than foreign firms do. In other words, building technological capabilities on the basis of in-house R&D seem to be more important for domestic firms in low-tech industries. Moreover, technology embodied in machinery and equipment and learning-by-doing (production process) have higher shares in domestic firms, whereas marketing-related activities account for almost one quarter of innovative activities in foreign firms. Foreign firms also spend proportionately more on transferring technology from abroad.

As may be expected, in-house R&D has a much higher share in innovation expenditures in high-tech industries, especially in foreign firms: it accounts for exactly half of innovation expenditures in foreign firms, and almost one third in domestic firms in the period 1998-2000. Domestic firms allocate somewhat higher proportions of expenditures for technology embodied in machinery and equipment and learning-by-doing activities. Marketing-related activities have almost the same share in domestic and foreign firms in high-tech industries.

Innovative firms in low- and high-tech industries have a similar pattern of R&D co-operation. The only major difference is the fact that co-operation with users takes place more frequently in high-tech industries. More than half of innovative domestic firms are not involved in any type of co-operation in R&D activities. Co-operation with foreign organizations is even less likely for domestic firms (about 10 % of innovative firms). On the other hand, irrespective of the sector they operate in, foreign firms have more intensive contacts with other organizations in R&D activities. The most important partner for foreign firms is their sister companies belonging to the same business group. However, they have closer links with domestic organizations, especially with domestic suppliers and universities, public organizations, and non-profit organizations.

4. Spillovers, technological activities, and productivity

There are substantial differences between domestic and foreign firms both in terms of innovativeness, and the way they perform technological activities. But what determines technological activities? What is the impact of innovativeness on productivity? In this

[9] Since the distribution is similar for 1995-1997 and 1998-2000 periods, we look at only the second time period.

section, we will answer these questions with a special emphasis on the impact of foreign ownership and spillovers from foreign firms. The analysis takes into account two sources of technologies, in-house innovative activities and technology transfer (from abroad).

We assume that technologies acquired through innovative activities or transfer processes improve the productivity of the firm as follows:

$$Q_{it} = f(A_{it}, K_{it}, L_{it}, E_{it}, M_{it}, SKILLED_{it}, LRWV) \quad [1]$$

$$A_{it} = A_0 e^{\delta INNOit + \gamma TECHNOit + \lambda t} \quad [1']$$

where Q is (real) output, K, L, E and M are (real) capital, labor, energy and materials inputs. SKILLED and LRW are the share of skilled employees and real product wages, respectively. These variables are used to control for labor quality. Subscripts i and t denote firm and time period, respectively. A_0 is the base-line productivity level, and δ and γ are the effects of innovation and transferred technologies, respectively, on productivity. The choice to be innovative and to transfer technology depends on a number of firm- and sector-specific factors as follows:

$$INNO_{it} = \alpha_0 + \Sigma\alpha_{ij}x_{ijt} \quad [2]$$

$$TECHNO_{it} = \beta_0 + \Sigma\beta_{ij}x_{ijt} \quad [3]$$

$$i = 1, \ldots, n, j = 1, \ldots, m$$

where x's are m variables that determine INNO and TECHNO variables. t denotes the time period (1995-1997 or 1998-2000). INNO and TECHNO are dummy variables that take the value 1 if the firm is innovative and transferred a technology through license/know how agreement, respectively. Since the innovation and technology transfer variables are endogenous in the output model (equation 1), we first estimate equations 2 and 3, and then estimate the output equation by adding the inverse-Mills ratios (obtained from the estimation of equations 2 and 3) to have unbiased estimation.

Spillovers from foreign firms are classified in three groups: horizontal spillovers, vertical spillovers, and labor turnover.

Horizontal spillovers: We use three variables to capture the effects of horizontal spillovers from foreign firms: The first variable, SFDI, measures the market share[10] of foreign (FDI) firms. If there are (sectoral) horizontal spillovers from foreign firms in the form of demonstration effects, imitation, etc., other firms in the same market may invest in innovative activities to benefit from spillovers. In a similar way, informational spillovers may make technology transfer more likely. If competition from foreign firms forces other firms to adopt better technologies through innovative activities and/or transferring technologies, the SFDI variable will have a positive coefficient as well. Although foreign firms are, on average, more productive than domestic firms, and, therefore, are likely to generate spillovers for domestic firms, R&D intensive foreign firms are likely to be the main source of spillovers. Therefore, we use two additional variables, SREGRD and SSECTRD, to estimate the impact of spillovers from R&D activities of foreign firms. The SREGRD variable is defined as the ratio of foreign firms' R&D expenditures to total output in the province where the firm operates, whereas the SSECTRD variable is measured similarly at the sectoral level. Thus, the SREGRD variable captures regional foreign R&D spillovers, and the SSECTRD variable sectoral foreign R&D spillovers.

Vertical spillovers: There are two variables used as proxies for the extent of vertical spillovers. SSUP and SBUY, measure the weighted average of foreign ownership in supplier and user industries, respectively. These variables are defined as follows:

$$SSUP_i = \Sigma \omega_{ij} s_j$$
$$SBUY_i = \Sigma \acute{\omega}_{ij} s_j$$

where s_j is the market share of foreign firms in market j, ω_{ij} the j^{th} sector's share in inputs used by the i^{th} sector, and $\acute{\omega}_{ij}$ the share of j^{th} sector in total consumption of the i^{th} sector's output. Thus, in a sense, SSUP measures the proportion of firm's inputs produced by foreign firms, and SBUY measures the proportion of firm's output used by foreign firms. ω and $\acute{\omega}$ variables are calculated from the 1996 Input-Output Table. If vertical relations are used to transfer knowledge from foreign firms, these two variables are expected to have a positive impact on technological activities.

[10] The "market" is defined at the ISIC 4-digit level (Rev.2).

Labor spillovers: There is an extensive literature that emphasizes the importance of tacit knowledge in technological activities (for a recent review and extensions, see Cowan, David and Foray, 2001). Technology is, at least partly, tacit and embodied in people who develop and use it. Therefore, the transfer of workers, formerly employed by foreign firms, could constitute an important channel for spillovers. Since there is no data about the flow of workers between firms, we use a proxy variable, SLABOR, to measure the extent of spillovers through labor flows. The SLABOR variable is defined as the ratio between the number of separations (quits and fires) from foreign firms to total number of employees in a given industry. Therefore, the higher the value of the SLABOR variable, the higher the probability that former employees of foreign firms would be employed by other firms operating in the same industry. If there are spillovers through labor turnover, the coefficient of the SLABOR variable will be positive.

Other variables included in the innovation and technology transfer models are as follows:

FDI is a dummy variable that takes the value 1 for joint ventures where the share of foreign ownership is 10 % or more. This dummy variable is used to test if foreign firms are more innovative and/or if foreign firms are more likely to transfer technology from abroad, possibly from their parents.[11]

The main input for innovation process is investment in R&D activities. The R&D intensity (RDINT, R&D expenditures/sales ratio) is used to determine the effect of R&D activities on innovation. Since there could be a complementarity between in-house R&D and technology transfer, it is also included in the technology transfer model. Moreover, the effects of regional and sectoral knowledge spillovers from domestic firms are captured by the R&D intensity of firms operating in the same province (DREGRD) and in the same sector (DSECTRD), respectively.

The size of the firm is considered to be one of the main determinants of innovativeness. Thus, we include the (log) number of employees (LL) to test the impact of firm size on technological activities. Moreover, the proportion of skilled employees, SKILLED, is used to test the contribution of skilled employees on innovation and technology transfer activities.

[11] We also experimented with a dummy for majority-owned foreign firms. Since most of the foreign firms in the sample are majority-owned foreign firms, there was not any major change in our results.

The effects of subcontracting relations on technological activities are tested by using two variables, SUBIN (the share of subcontracted inputs in total inputs) and SUBOUT (the share of output subcontracted by other firms in total output). These variables are used to check if subcontract-receiving (SUBOUT) and subcontract-offering (SUBIN) firms are more innovative/more likely to transfer technology from abroad.

Finally, there are three additional firm-specific variables: GROUP is a dummy variable that takes the value 1 if the firm belongs to a business group. This variable is used to test if membership in a business group yields any benefit for technological activities. The variable INTERNET is defined by the proportion of employees who have direct access to the Internet on the job. If technological activities require extensive exchange of information (and, of course, if the Internet provides the basis for information exchange), this variable is expected to have a positive coefficient in both innovation and technology transfer models. The third variable, LTURN, is the ratio of the number of separations in a year to the average number of employees (average employment *plus* the number of separations). This variable is used to measure labor flexibility that is likely to have a negative impact on innovative activities (see Kleinknecht, 1998; Michie and Sheehan, 2003).[12]

Table 4 presents descriptive statistics on all variables used in the regression analysis. As mentioned in the previous sections, the shares of innovative and foreign firms are much higher in high-tech industries than in low-tech industries. Moreover, the share of technology transferring firms is also higher in high-tech industries. Firms in high-tech industries are somewhat smaller than firms in low-tech industries, but spend proportionately much more on R&D activities. (However, note that the average R&D intensity is only 0.22% for firms in high-tech industries.) Regional R&D intensity is almost the same for both groups of firms, i.e., high-tech firms do not cluster in specific regions (provinces), but, as expected, sectoral foreign and domestic R&D intensity (SSECTRD and DESCTRD) is much higher in high-tech industries. The average market share of foreign firms is higher in high-tech industries, and foreign firms have a larger market share in supplier industries. Finally, the possibility that a firm will employ a former employee of a foreign

[12] The Innovation Surveys are available for two time periods, 1995-1997 and 1998-2000. The data for these two time periods are pooled together in the regression analysis, and a dummy variable for the second period is used to capture exogenous changes in the dependent variables over time. Moreover, dummy variables for 2-digit industries are added into all models to control for unobserved sector-specific factors.

firm is much higher in high-tech industries than in low-tech industries because of the larger share of foreign firms in high-tech industries.

Regression results summarized in Table 5 show that labor spillovers from foreign firms contribute significantly to the competitiveness of Turkish manufacturing firms. However, as may be expected, labor spillovers do not have any impact on the probability to transfer technology from abroad. This finding indicates that tacit knowledge, embodied in people, plays an important role for innovativeness. Moreover, in supporting this argument, the SKILLED variable (the proportion of skilled employees) is also found to be one of the main determinants of innovativeness.

Horizontal spillovers, neither the foreign presence in the industry, nor R&D spillovers, make any contribution to technological activities (neither innovation nor technology transfer). There seems to be some regional spillovers from R&D activities of foreign firms in low-tech industries, but the coefficient of the variable SREGRD is statistically significant only at the 5% level. Economic significance of regional spillovers in low-tech industries is also low because of low level of R&D intensity.

Vertical spillovers are significant for only innovativeness in high-tech industries, but with mixed outcome. Foreign investment in supplier industries seems to be detrimental to innovative activities: the higher the share of foreign firms in supplier industries, the lower the innovativeness of firms in user, high-tech industries. On the other hand, foreign users of high-tech products induce high-tech firms to be more innovative. This finding may point to the importance of users in technological activities (for the importance of "learning from users", see Carlsson and Jacobsson, 1991).

Since most of the spillover variables have statistically insignificant coefficients, we estimated a number of additional models to test the robustness of our results. First, we estimated our models by excluding all but one spillover variable to eliminate possible multicollinearity among spillover variables. The results for the models including only one spillover variable are qualitatively the same as those obtained by including all spillover variables together. The only difference is that the presence of foreign firms (the SFDI variable) in high-tech industries becomes significant at the 5% level in the technology transfer model. Second, it is suggested in the literature that domestic firms can benefit from

spillovers only if they are equipped with necessary technological capabilities/absorptive capacity. We used two variables, the firm size (dummy) and the share of skilled employees as measures for domestic firms' capabilities, and used interactions of these variables with spillover variables to test if larger firms or firms that employ skilled people do benefit more from spillovers from foreign firms. Among 24 coefficients estimated for the innovation models, only one turned out to be statistically significant at the 5% level.[13] In other words, size and skill interactions did not change our results.

Among other explanatory variables, foreign ownership is found to matter for innovativeness in high-tech but not in low-tech industries. However, foreign ownership is one of the main determinants of technology transfer in both sectors: foreign firms seem to prefer to transfer technology from abroad.

Firm size has a positive impact on innovative activities in low-tech industries, and technology transfer in high-tech industries. It seems that small firms are as innovative as large firms in high-tech industries where innovativeness is essential for competitiveness. High-tech firms belonging to business groups tend to transfer technology, but, apparently, business groups fail to improve innovativeness of their members. As expected, R&D intensity is conducive to innovativeness. Sectoral knowledge spillovers from domestic firms encourage innovativeness in only low-tech industries, but regional spillovers do not have any impact on technological activities. The access to internet has a positive impact on innovativeness in both sectors, and labor turnover, i.e., labor flexibility, has a negative impact on innovativeness in low-tech and high-tech industries although the latter one is not statistically significant. Subcontracting relationships do not play any role in technological activities.

Estimation results of production functions reveal a difference between low-tech and high-tech industries. Although the coefficients of input variables (except labor input variables, LL and SKILLED) are almost the same for low-tech and high-tech industries, the innovativeness variable has a somewhat larger coefficient in the high-tech industries model. It seems that

[13] The interaction between the SFDI and SKILLED variables has a statistically significant (at the 1% level) negative coefficient in the innovation model for low-tech industries, i.e., those low-tech firms that employ more skilled people benefit less form foreign presence in their sectors. In the case of technology transfer models, only four out of 24 interaction variables had coefficients statistically significant at the 5% (size-SFDI, size-SSECTRD, and size-SBUY interactions had positive coefficients, and SKILLED-SSECTRD interaction had negative coefficient in high-tech industries).

what matters for productivity in high-tech industries is internally generated technological capability. Technology transferred from abroad improves productivity neither in low-tech nor in high-tech industries after controlling for all other variables. It is interesting to observe that although foreign ownership makes low-tech firms more productive, it does not have any impact on productivity in high-tech industries where foreign firms are assumed to be in a more advantageous position. Foreign firms in high-tech industries seem to be more productive only if they become more innovative.

5. Conclusions

FDI has been considered by many development economists as an important channel for transfer of technology to developing countries. It is suggested that modern, advanced technologies introduced by multinational firms can also diffuse to domestic firms through spillovers. Our analysis shows that foreign firms in Turkey are more innovative in than their domestic counterparts in medium- and high-tech industries, but not in low-tech industries. However, in both industries, foreign firms tend to transfer technology from abroad (mostly from their parent companies).

The type of spillovers seems to matter: horizontal spillovers, neither the foreign presence in the industry, nor foreign R&D spillovers, make any significant contribution to technological activities (neither innovation nor technology transfer) in low- and high-tech industries. There are no vertical spillovers in low-tech industries and their effect on innovativeness of medium- and high-tech firms is ambiguous. Foreign users induce innovativeness of medium- and high-tech suppliers, i.e., the “user competence” seems to be important, but foreign presence in supplier industries is harmful for innovative activities of users in medium- and high-tech industries. The main channel of spillovers is labor turnover. Our findings reiterate the importance of tacitness of knowledge, and confirm that technology cannot easily be transferred through passive mechanisms (demonstration effects, imitation, etc.).

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Table 1. Innovativeness of domestic and foreign firms, 1995-1997 and 1998-2000
(proportion of innovative firms)

	1995-1997			1998-2000		
	Domestic firms	Foreign firms	Majority-owned foreign firms	Domestic firms	Foreign firms	Majority-owned foreign firms
Product innovations						
Low-tech	0.112	0.091	0.065	0.143	0.162	0.175
Medium- and high-tech	0.278	0.526	0.493	0.325	0.601	0.614
Process innovations						
Low-tech	0.159	0.163	0.126	0.193	0.387	0.435
Medium- and high-tech	0.280	0.453	0.423	0.279	0.483	0.480
Innovative (product and/or process innovations)						
Low-tech	0.191	0.169	0.130	0.250	0.425	0.476
Medium- and high-tech	0.378	0.563	0.541	0.419	0.680	0.685
Product/process innovators ratio						
Low-tech	0.704	0.558	0.516	0.741	0.419	0.402
Medium- and high-tech	0.993	1.161	1.165	1.165	1.244	1.279
n						
Low-tech	1301	68	44	1391	83	66
Medium- and high-tech	646	79	45	770	94	67

Source: SIS, *Innovation Surveys*, 1998 and 2002.

Table 2. Distribution of innovation expenditures, 1998-2000

	Domestic firms	Foreign firms	Majority-owned foreign firms
Low-tech industries			
In-house R&D	0.147	0.050	0.048
Contract R&D	0.016	0.006	0.007
Machinery & equipment	0.698	0.606	0.608
Technology transfer	0.020	0.101	0.106
Production process	0.041	0.004	0.004
Training	0.027	0.005	0.006
Marketing	0.051	0.227	0.221
n	223	19	17
Medium- and high-tech industries			
In-house R&D	0.297	0.503	0.502
Contract R&D	0.020	0.010	0.011
Machinery & equipment	0.443	0.352	0.340
Technology transfer	0.034	0.019	0.021
Production process	0.087	0.028	0.033
Training	0.021	0.023	0.027
Marketing	0.098	0.065	0.066
n	228	40	29

Source: SIS, *Innovation Survey*, 2002.

Table 3. R&D co-operation by ownership, 1998-2000
(proportion of R&D co-operations)

Partner		Domestic firms	Foreign firms	Majority-owned foreign firms
Low-tech industries				
Domestic	Own group	0.060	0.050	0.044
	Users	0.060	0.074	0.072
	Consultants	0.041	0.213	0.226
	Suppliers	0.087	0.243	0.227
	Universities/non-profit	0.151	0.252	0.247
Foreign	Own group	0.007	0.194	0.194
	Users	0.003	0.089	0.088
	Consultants	0.070	0.031	0.012
	Suppliers	0.037	0.088	0.055
	Universities/non-profit	0.003	0.010	0.011
n		470	49	41
Medium- and high-tech industries				
Domestic	Own group	0.051	0.038	0.005
	Users	0.102	0.451	0.552
	Consultants	0.042	0.297	0.353
	Suppliers	0.074	0.176	0.148
	Universities/non-profit	0.094	0.216	0.204
Foreign	Own group	0.002	0.594	0.718
	Users	0.041	0.137	0.129
	Consultants	0.023	0.086	0.027
	Suppliers	0.039	0.132	0.104
	Universities/non-profit	0.008	0.023	0.023
n		402	71	50

Source: SIS, *Innovation Survey*, 2002.

Note: The total may exceed one because a firm can co-operate with more than one type of organization.

Table 4. Descriptive statistics
(average values for the periods 1995-97 and 1998-2000)

Label	Variable definition	Low-tech industries	Medium- and high-tech industries
Innovation and technology transfer			
INNOVAT	Innovativeness	0.25	0.44
TECHNO	Technology transfer	0.01	0.07
FDI spillover variables			
SLABOR	Labor turnover in foreign firms	0.01	0.02
SFDI	Market share of foreign firms	0.10	0.31
SREGRD	Regional foreign R&D intensity (percentage)	0.06	0.06
SSECTRD	Sectoral foreign R&D intensity (percentage)	0.00	0.09
SSUP	Market share of foreign firms in supplier ind	0.07	0.12
SBUY	Market share of foreign firms in user ind	0.03	0.07
Foreign ownership			
FDI	Foreign-owned firm (foreign ownership 10%+)	0.03	0.06
FDIMAJ	Majority-owned foreign firm	0.02	0.05
R&D and R&D spillovers			
RDINT	R&D intensity (percentage)	0.02	0.22
DREGRD	Regional domestic R&D intensity (percentage)	0.04	0.05
DSECTRD	Sectoral domestic R&D intensity (percentage)	0.02	0.09
Other variables			
LTURN	Labor turnover ratio	0.14	0.15
INTERNET	Internet intensity	0.54	0.71
GROUP	Member of a business group	0.07	0.08
SUBIN	Share of subcontracted inputs	0.05	0.03
SUBOUT	Share of subcontracted outputs	0.07	0.01
SKILLED	Proportion of skilled employees	0.16	0.20
LQ	Output (log)	10.95	10.90
LL	Employment (log)	3.90	3.75
LM	Inputs (log)	10.50	10.28
LE	Electricity consumption (log)	12.74	12.39
LK	Depreciation allowances (log)	7.17	7.17
LRW	Real product wage (log)	4.86	5.35
n	Number of observations	1978	1043

Table 5. Determinants of innovativeness, technology transfer and productivity

	Low-tech industries						Medium- and high-tech industries					
	Innovativeness		Technology transfer		Production		Innovativeness		Technology transfer		Production	
	Coeff	Std dev	Coeff	Std dev	Coeff	Std dev	Coeff	Std dev	Coeff	Std dev	Coeff	Std dev
Labor spillovers												
SLABOR	11.45	2.88 **	-6.91	22.61			7.78	3.22 *	5.55	6.86		
Horizontal spillovers												
SFDI	0.22	0.33	-0.89	1.57			-0.09	0.26	0.61	0.52		
SREGRD	0.73	0.35 *	0.47	3.79			-0.63	0.59	0.82	1.55		
SSECTRD	20.07	29.73	-7.03	275.59			-0.15	0.50	-0.44	1.04		
Vertical spillovers												
SSUP	-1.64	1.09	1.98	5.97			-2.33	0.72 **	0.61	1.55		
SBUY	0.61	0.94	-1.57	4.03			2.19	0.87 *	3.27	2.81		
Foreign ownership												
FDI	0.05	0.19	1.81	0.48 **	0.11	0.03 **	0.47	0.19 *	1.17	0.26 **	0.05	0.03
R&D and R&D spillovers												
RDINT	25.38	9.63 **	6.97	34.71			25.44	5.73 **	7.31	4.06		
DREGRD	-0.40	0.46	-3.44	8.88			0.53	0.52	0.41	1.14		
DSECTRD	5.35	1.44 **	1.69	7.16			-0.14	0.49	-0.09	1.10		
Other explanatory variables												
LTURN	-0.66	0.30 *	-0.05	2.55			-0.46	0.37	0.27	1.07		
INTERNET	0.84	0.08 **	0.35	0.49			0.99	0.13 **	0.56	0.41		
GROUP	0.04	0.13	0.38	0.60			-0.03	0.20	0.58	0.27 *		
SUBIN	-0.64	0.41	-0.08	2.15			-0.67	0.76	1.62	1.42		
SUBOUT	0.33	0.19	-5.23	13.61			-0.56	0.71	-0.46	2.00		
SKILLED	0.69	0.23 **	-0.61	1.94	0.00	0.02	1.06	0.31 **	0.61	0.77	0.23	0.05 **
LL	0.17	0.03 **	0.30	0.18	0.13	0.01 **	0.06	0.05	0.60	0.10 **	0.22	0.01 **
LM					0.68	0.00 **					0.67	0.01 **
LE					0.06	0.00 **					0.03	0.01 **
LK					0.08	0.00 **					0.07	0.01 **
LRW					0.00	0.00 **					0.00	0.00 **
INNOVAT					0.25	0.03 **					0.31	0.04 **
TECHNO					-0.04	0.11					0.00	0.06
λ_{INNO}					-0.12	0.02 **					-0.17	0.03 **
λ_{TECHNO}					0.01	0.05					-0.02	0.04
$\rho_{INNO-TECHNO}$	0.072	0.274					0.065	0.141				
n	1978				1978		1042				1042	
Log-likelihood	-1007				-793		-756.25	-1595			-433	
Spillovers test	48.4 **						41.3 **					
Adj. R2					0.945						0.948	

Note: All models include sector dummies for ISIC 2-digit industries, a dummy for year 2000, and a constant term.

** (*) means statistically significant at the 1% (5%) level, two-tailed test.

Figure 1. Share of foreign firms in manufacturing employment and value added in Turkey, 1984-2000

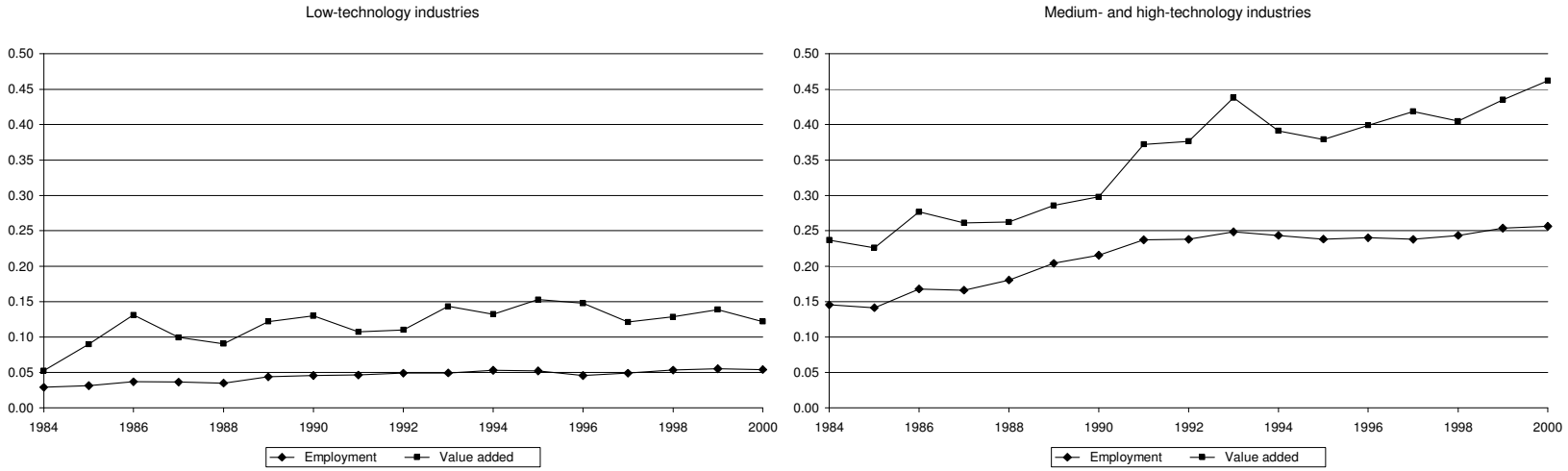

Figure 2. Labor productivity, domestic and foreign firms in Turkey, and US firms, manufacturing industries, 1984-2000